1750 METERS: WESTERN UPDATE #59

THE WESTERN NEWSLETTER FOR THE EXPERIMENTER'S BAND (160 TO 190 KHZ)

Available for business-size 25 cent SASE's, plus 60 cents per issue (or $7 per year)
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ACTIVE WESTERN LowFER BEACON STATUS (LIST COMPILED September 24, 1988)

FREQ(kHz)	IDENT	QTH	SKED INFO
162.35a	XU	San Ysidro, CA	24h/7d. Using a VFO.
163.80	FPV	Granada Hills, CA	24h/.7d. See alt. freq. 182.62 kHz.
163.85	M	San Diego CA	Testing sometimes..
✓166.503	C	near Morro Bay, CA	24h/7d. Note QSY.
166.667	H	Descanso, CA	24h/7d
167.25	AHN	Fallbrook, CA	24h/7d
169.863	1SUN	Durant, OK	Schedule unknown.
175.225	MAX	Wheatland, WY	24h/7d CW. BPSK/ASCII by request.
175.703	FAW	Orem, UT	24h/7d
176.00	HDOMBAY	Morro Bay	24h/7d
176.26	C O	Glenwood Springs, CO	24h/7d
176.75	SR	Elgin, OR	24h/7d.
✓177.48	UCP	Saratoga, CA	Daily, approx. 1400 to 1700 UTC.
177.750	CT	Bountiful, UT	24h/7d (BPSK/CCW alternating)
178.00	AT	Crow, OR	Off until Fall
179.0	MPM	Salt Lake City, UT	24h/7d ASCII/CW alternating 5minutes.
180.224	F	Los Banos, CA	FSK. By request.
180.66	NRE	San Diego, CA	24h/7d.
181.17	IZJ	San Gabriel, CA	Daily. Silent 0700 to 1100 UTC.
✓181.287	MEL	San Jose, CA	24h/7d.
✓181.711	TLX	Novato, CA	24h/7d
182.62	FPV	Granada Hills, CA	24h/7d. See alt. freq. 163.80 kHz.
✓✓182.672	G	Palo Alto, CA	24h/7d.
✓182.88	H2	Descanso, CA	24 hours Friday, Saturday, Sunday.
✓183.160	PRK	Saratoga, CA	24h/7d
183.63	PLI	Toluca Lake, CA	24h/7d
✓183.95	8 dits	Palo Alto, CA	Intermittent tests Same QTH as "G".
184.016	EK	Sunnyvale, CA	24h/7d
✓184.43	V	Forestville, CA	24h/7d. Note new location.
185.0	ZYK	Redway, CA	24h/7d
185.49	AZ	Tucson, AZ	24h/7d.
186.80	BA	Lancaster, IL	24h/7d.
187.0	ELU	Simi Valley, CA	24h Saturday and Sunday on SSB
187.252	TEXAS	NW of Ft. Worth, TX	24h/7d.
187.263	SKY	9 mi. NW of San Simeon, CA	Down for repairs.
187.30	UPN	Cincinatti, OH	Occasional
187.50	DCH	Berlin, MD	24h/7d.
✓187.47	SM	San Jose, CA	Intermittent.
190.4	OHH	Richmond Hill, Canada	Occasional testing.

5 MORE SASES ON FILE

(Check means sig logged at EK QTH in August/September. Double check is QSO with EK. Non-Western listings are beacons currently being copied in the West, or they have SASE's on file with us). "a" means frequency is approximate (non-crystal controlled).

EK NOTES: This turned out to be the "transmitter efficiency" issue because we received four technical articles (variations on the same theme) from **Mark Mallory, Max Carter, James Coote,** and **Frank Cathell**. I thought it would be worth the extra postage and pages to publish all of them in the same issue of **WU**. Read them carefully and then send in your comments. From my perspective it seems like anything we do to improve efficiency is fine, as long as we make darned sure that our radiated harmonics are within legal limits.

Listening seems to be picking up nicely, so dust off that receiver and poke around! Hope that you enjoy this version of WU as much as I enjoyed putting it together. Thanks again to everyone who submitted material.

MAILBAG: Steve McGreevy (TLX) returned 9/19 from a one week DXpedition to eastern Nevada and western Utah. Here's a summery of his report. "On Tuesday, 9/13 at Elkhorn Summit, NV using a 1400 foot beverage wire to the west I copied **TLX** and **PRK** strength QRK 1 to 2 at 1400 PDT. On Wednesday 9/14 at Monitor Valley, NV at 4:30pm local I copied **FAW** and **MPM** QRK 4 to 5 (MPM was about 3 dB stronger). Did not copy **CT**. About 5pm copied **TLX** and **PRK** at QRK 1. In the evening I copied glitchy rapid bursts of digital-sounding transmissions on 204, 224, 229, 238, 313, 335 and 370 kHz. The signal had no resemblance to **GWEN**. They nulled on a 90/270 degree bearing. I suspect they are a frequency hopping/spread spectrum data link between the Eureka, NV radar site and Fallon Naval Air Station. These data bursts were much weaker on Wheeler Peak, ruling out Utah. Early Thursday morning 9/15 copied **H, TLX, PLI** at QRK 2 to 3. Friday 9/16 at Wheeler Peak (far eastern NV) using a 1400 foot east/NE wire I copied **FAW** and **MPM** (very loud), **MAX** was QRK 1 to 2. **H2 and PLI** were a loud QRK 3. In the late afternoon **TLX and PRK** were QRK 2+. But no **C, H, or EK**! Monday 9/19 near Garrison, Utah with a 2000 foot west wire copied **SA** at QRK 4+ (SA is Steve's Medium Frequency experimental beacon on 522.620 kHz). **H2 and PLI** were QRK 2 to 3. **TLX and PRK** were QRK 2. Finally copied **EK** QRK 2 at 0542. Tuesday morning 9/20 from a canyon off Highway 722 in Nevada with a 1000 foot west wire I copied **TLX, PRK, EK, PLI** QRK 3. No trace of **C, H, V**, but **MPM and FAW** were QRK 3." Steve stayed in contact during the trip on 75 meter Ham CW with WB6EER, KG6EK, W6HDO, and K6BMW. Thanks much Steve for the detailed report!

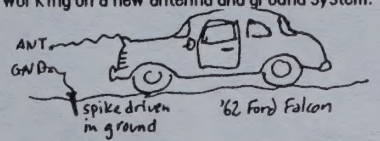
Bob Costa (KB6QXM) writes from Redwood Estates, CA that, "I will probably be putting all my efforts into a PLL controlled XCVR. My goal is to be operational by mid to late '89."

James Coote (J) of Los Angeles has been hearing locals **IZJ, PLI, FPV, and H2.** James says, "I use a Burhans whip and converter in my mobile setup with an Icom 735. Converters don't just add spectrum coverage - they also put the IF up where most radios have better specs for sensitivity."

Frank Cathell (H2, H) writes from San Diego that he is only hearing **NRE and XU**. He notes, "NRE has been steadily improving (QRK 5 day and night), while XU continues to drift between 162 and 164 kHz. Also Jim, in the Class-F transmitter article I wrote for WU#58, I forgot to mention that the broadband tank circuit L1 and C6 should be resonated slightly higher than the operating frequency. This will assure a pure half-sine wave on the drain of Q1 when it switches off. It will also minimize harmonics and maximize efficiency."

Max Carter (MAX) reports in from Wyoming that, "Major LowFER activity here in late Summer was the raising of my beacon transmitting mast to 40 feet from its original height of 31 feet. The tophat is a 16 foot (8 foot radius) x 5 foot 'H' made with aluminum tubing. If it's still standing next spring, I'll raise it another 10 feet!"

A short note from **David Holland (DCH in MD)** says, "**DCH** is back on the air. I have been working on a new antenna and ground system. Tests indicate that it is working better than the old setup."



Portable E-field receiving antenna. Works good. A little hard to start on cold mornings unless you get a good pre-dawn enhancement. -D.J. "F"

David Johnson (F, Los Banos, CA) sent the humorous sketch of his latest receive antenna for LowFER signals! It's no joke! In his letter David comments, "I picked up the following signals on the morning of 9/17 :**MEL, EK, PRK, and SM.** This is far and away my best reception so far, made possible by using my '62 Ford Falcon as a receiving antenna. It's definitely better than my 1 meter square loop."

Greg Farkas (AZ, of Tucson, Arizona) writes that his beacon is back on the air after a summer rest. He also reports copying **MPM** in Utah on the evening of 9/10 at 0257 UTC.

Clint Turner (CT of Utah) says, "I plan to resume full normal beacon operation (the 15 minute mixed-mode format) by October 1st. At the moment I am still intermittently running LSB transmissions on a 1 minute loop tape approximately on my normal frequency."

Clint has also been busy on a BPSK transmitter design which he hopes to complete this year.

Wallie Jones (W6SZQ, Arleta, CA) joined the Western Update crew this month, and seems to like the newsletter. Wallie hopes to have a beacon on soon from Arleta, and notes that he has been a Ham since 1930 (ex **W9EQQ** in Chicago). He comments, "Congratulations, I think WU is worth more than you are charging for all that effort." Be advised we accept Visa, American Express, and Mastercharge. Just kidding!

Art Peterson wrote a card from Richmond, CA to report good reception of **ZYK** in July from Cape Mendocino using a Sony 2002 and active whip. On the subject of NDB's Art says, "On the morning of 9/10 copied **ZY - 302, Yukon, 400 Hz**...giving my first new province in 23 years! (Only **PEI** is left). This is going to make Yukon Territory a lot easier to log for many DX-ers."

Glen Smith (N6CX of Kenwood, CA) wrote, "While grubbing around and cleaning up this messy ham shack I ran across your May 1987 WU. I almost forgot about it, since the press of work here with my vineyard and huge garden has kept me very busy all year. Now that the grape harvest is over, I will have more time to get active again. I hope GWEN hasn't entirely disrupted LowFers! I have an old RBL receiver and it has finally given up the ghost. Turned it on to see if there was life on the 1750 meter band and smoke poured out of every crack. I suspect the WW-2 'mud' bypass caps have finally shorted out. So, now comes the task of finding suitable substitutes."

On the Sunday morning Ham net for LowFERS, we've been hearing about Packet activity on 1750 meters down in the Los Angeles area. **David Curry (PLI)**, bless his heart, kindly followed up with the following note elaborating the Packet activity: "Charles (**FPV**), Randy (**ELU**) and myself are testing and evaluating different communication modes such as Amtor, RTTY, and Packet on 1750 meters. So far excellent results have been produced, especially with Amtor. It seems to be the best overall when considering noise and ease of copy. What is nice about Packet is that you can monitor other beacons on the same frequency and have a bulletin board setup...and still alternately transmit your own bulletin. For communication work however, it seems Amtor definitely wins out. Packet is very touchy and not as reliable. We are using the Packratt PK 232 modem, and PC clone computers. We are interested if anyone else is capable of using any of these modes? We are as usual having our SSB net on 186 kHz at 9am every Saturday morning, and usually transfer to RTTY or Amtor after 30 minutes or so. Around 10 to 10:30am we QSY up to 40 meters (7.29 MHz or thereabouts) to confirm the QSO and meet with those who have heard us and want to join in with comments."

EK NOTES: Thanks for the good technical articles which keep appearing in my mailbox! We still have a backlog of two or three for upcoming issues, but we still need more inputs. If you're writing for publication, please be neat, use black pen for drawings and schematics, and use a fresh ribbon in the typewriter. Photocopier machines can only do limited magic!

A word on the accuracy of beacon listings, and the active address list. This information is only as good as what I receive. If you plan on making a change and are too busy to write a letter, at least drop me a quick postcard with the barebones info.

You will note that more and more material in **WU** has been reduced to fit on half a page. I don't much like it either, but it's the only way to get the information out without raising the costs. Also, starting with this issue I will orient reductions with the top facing to the left. People at my copy store assure me that this is correct form.

Listening has been pretty good here lately. I copy the **C** beacon in Morro Bay QRK 1 to 2 on a quite regular basis (path is 175 miles). **TLX** (55 miles) is always QRK 3. The new **V** beacon (90 miles north) is QRK 1 to 2. **V** is actually my homebrew portable beacon which I loaned to **Herb Vanderbeek**. He installed it recently at a relatives QTH. I also copied the **H2** San Diego beacon in the last week or so. Very weak but identifiable over a path of around 400 miles. The **T** beacon from Sonoma State University (placed there by **Steve McGreevy**) was consistently QRK 2 here for a long time. Unfortunately, T is now permanently off the air. My best listening time is 9am to noon. Other times it seems to be dimmer city!

Scott Mawhinney had a test beacon **SK** running for a few days recently from his new QTH in Mountain View (about 3 miles north of me). He was running AM mode and had a strong signal. Curious, I DF'd the beacon and wound up having a nice talk with Scott. He's got a very well implemented vertical with several sloping tophats. He's presently designing a more conventional transmitter, and I wouldn't be surprised to hear a new beacon soon!

Herb Vanderbeek (G) did another LowFER demo at the September 10 electronics flea market. His transmitter and receiver were set up and operating, and I got a chance to help out for a couple of hours by talking to interested passersby. Later when I returned home, Herb and I had a nice QSO. On October 5th Herb and I have been invited to do a LowFER talk/demo at the meeting of the **Santa Rosa Amateur Radio Club**. Promotions like these seem to get a lot of interest, and are kinda fun! Anyone else doing things along these lines?

Don't forget the California LowFER nets on amateur radio. Sunday mornings at 7:30am on 3927 kHz LSB. Thursday nights after dark on 1987.5 kHz LSB. Either one is a good way to stay up to date. See you there, and 73.

Jim

960-1041

*295 PETTIS AVE. MV 94041

Z2 NEWS FOR WU*59 - by: Mike Midoke, PO Box 123, San Simeon, CA 93452. September 17th - QRN returned to midsummer levels for a few evenings recently, probably due to hurricane activity. But the band is opening up on quieter nights. On September 10 and 13, both MPM and FAW from the Salt Lake City area were doing quite well here at around 800 miles. On September 12 (Sunday night Pacific time) Sheldon Remington again copied Frank Cathell's H2 beacon...with an excellent signal that hung in there for quite awhile.

I began hearing FAW and MPM again on the 17th. With these receptions in mind, I predict plenty of single-hop 1750M propagation and instances of multi-hop during the coming months. Man-made noise will continue to be the limiting factor for most listeners.

There has been a transmitter or battery failure at my remote SKY site, so that facility is now completely off the air pending installation of a new antenna and ground system. At present I have no idea when I will be able to begin work on this project.

Contrary to notices in Northern Observer and possibly elsewhere, I have NO operational MF beacons either on 160M or the AM broadcast band. Maybe later, but with both time and cash in acutely short supply, I can do only a tiny fraction of the projects I'd LIKE to do!

WHISTLERS - For those who are not familiar with the subject, whistlers are characterized as descending tones, mainly heard in the 300 Hz to 8000 Hz region (though they may be found much higher and somewhat lower). For the most part these signals are generated by RF energy from lightning strokes penetrating the ionosphere and being conducted along magnetic lines of force between the two polar regions. The lightning stroke generates a broadband signal, and transmission path characteristics dictate that higher frequency components travel faster than low frequencies. So when we hear broadband signals via the whistler mode they are dispersed over time with the highest frequencies arriving first...hence the "whistle effect".

On a scientific level, these signals provide valuable insights into the earth/space environment out to several earth radii. On an esthetic level, whistlers are primal radio -- songs the Earth Dragon has been singing since long before there were human ears to hear. Like snowflakes, whistlers come in infinite variety. I'm afraid I've found their "program" more satisfactory than the majority of manmade signals! Few share this view. My mutterings about "no advertising" drew only bewildered stares.

Besides whistlers, there are other related things to be heard in the sub-10 kHz area but we can save them for another time.

Be aware that whistlers are not all that common and that manmade noise precludes the possibility of hearing any but the strongest in urban areas. Looking at my logs for May 17 through September 1, I see that whistlers or related activity were noted on 40 days. On about 10 of those days some strong and very strong signals were heard. I suspect some of these would have been readily detectable even in a quite noisy environment.

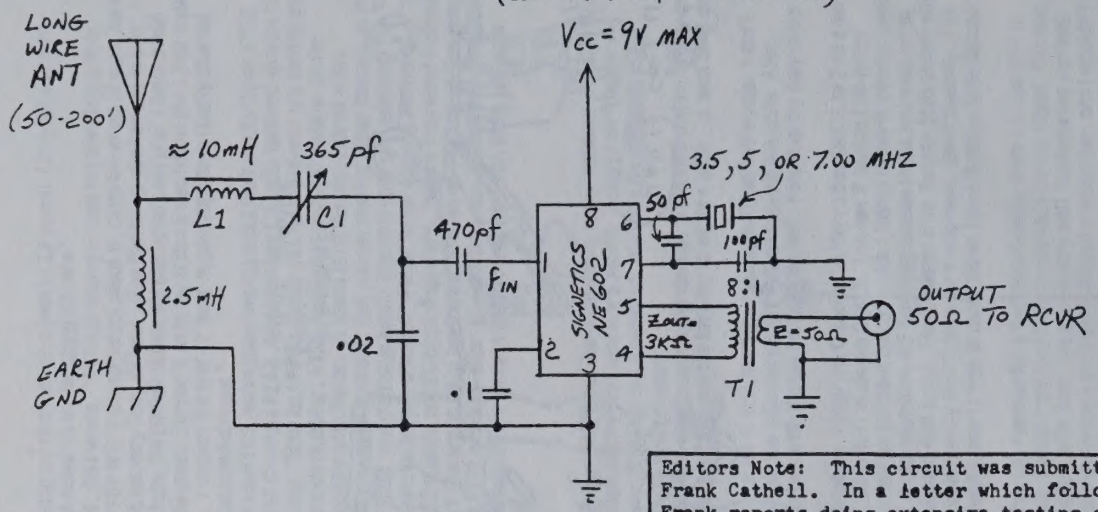
I am not sure that whistlers can tell us anything directly relevant to 1750M operation. The condition of the lower regions of the ionosphere does have a bearing on the generation and reception of whistlers and it may be that whistler activity can provide an indicator of some sort, but not one that is likely to be very useful.

I do expect to continue with a regular whistler monitoring schedule for at least the next several months. Whistler activity will be reported in "Propagation Report" in THE LOWDOWN, and more detailed articles (including receiving circuits) are in the works. For those interested in whistler-related reading, here are three good sources: "How to Listen for Whistlers", W.C. Johnson (W1FGO), QST March 1960. "Whistlers and Related Ionospheric Phenomenon", a textbook by Dr. Robert A. Helliwell, Stanford Press 1965. "Design of Broadband VLF Receivers with Air Core Loop Antennas", an excellent paper by Ev Paschal of Stanford University available for $5 postpaid from Ev at 61 Yale Road, Menlo Park, CA 94025.

73 - mike

LOW FREQUENCY CONVERTER

APPROX 20 TO 400 KHZ
(CENTER FREQ = 200KHZ)



Editors Note: This circuit was submitted by Frank Cathell. In a letter which followed, Frank reports doing extensive testing on the converter and reports excellent performance all the way down to 5kHz. Omega reception is good at 10 kHz with no tuned circuit on the input.

NOTES:

1. $f_{OUT} = f_{XTAL} + f_{IN}$

2. L1 VALUE DEPENDS ON ANT. LENGTH — SHORTER ANT WILL MEAN LARGER L VALUE. 10mH OPTIMUM FOR 100' WIRE.

3. C1 CAN BE DOUBLE SECTION (365pf/365pf) IN PARALLEL FOR GREATER FREQ. COVERAGE.

4. T1 IS FERRITE XFMR : Z_{in} = 3KΩ , Z_{OUT} = 50Ω (≈8:1 TURNS RATIO)

TWO OPINIONS ABOUT BLANKER BANDWIDTH Dave Johnson "F"

The purpose of a blanker in a radio receiver is to momentarily disconnect the signal path during the presence of a noise spike. Noise spikes are commonly caused by powerline interference (usually spikes at a 120 Hz rep rate), thunderstorms, and automobile ignition systems. Blanking protects the tender ears of the radio listener, enabling him/her to hear desired signals more easily, free of masking by impulse noise. Clippers (limiters) serve the same purpose, generally more cheaply and less effectively. The following discussion probably applies to clippers also.

OPINION #1, popular in the Lowfer press these days, is that a blanker should "see" and act on as wide a bandwidth as possible. At least one member has suggested blanking in the antenna circuit!! and this may be optimum under some conditions. A wide bandwidth minimizes "smearing" due to ringing of high-Q tuned circuits, which helps to keep the blanked periods as brief as possible. Also, impulse noise tends to increase in proportion to bandwidth, unlike Gaussian noise (such as thermal noise or "hiss") which increases as the square root of the bandwidth. This makes it easier to recognize impulse noise as the bandwidth becomes greater.

Although I have no practical experience with blankers (yet), and although I agree with Opinion #1, I would like to proffer a contrarian opinion, to wit:

OPINION #2. A better compromise is to put the blanker in the I.F. stages, with flat group delay filters (not the customary Butterworth or Chebbie filters) upstream. An extremely wide bandwidth increases the probability that a coherent signal strong enough to disable the blanker will lie within its bandwidth. It also increases the probability of multiple path or nonlinear phase propagation smearing the noise spike. Furthermore, the spectrum of the impulse is not usually constant during the duration of the pulse, and the duration of the noise envelope within a given restricted frequency band may be much shorter than the duration of the envelope of the entire impulse.

To provide good blanking, the bandwidth must be great enough to resolve the basic envelope of the most common impulse noise sources--powerline interference, lightning, and automobile ignition. This means a bandwidth of several kHz, or perhaps a bit more in the case of ignition noise. The filter that produces the bandwidth should have relatively flat group delay in order to minimize smearing. If the application requires a flat-topped, steep skirt filter (e.g., SSB work) this filter can be installed immediately downstream of the blanker.

.....Comments, anybody?

OPTIMIZING THE "SIMPLE BEACON" TRANSMITTER

by Mark Mallory, MPM

My LowFER beacon, MPM, has been on the air for some time, utilizing a dual MOSFET push-pull transmitter design. Despite it's complexity I've been quite proud of the circuit, which I considered to be hard to beat for DC to RF efficiency. Because I have received several requests for a description of the circuit, and since efficiency has recently become a "hot" topic, I had planned on writing a short article on the transmitter.

However, no sooner had I began than I ran across Frank Cathell's article (WU #58) on Mike Mideke's "simple beacon". I'd previously glanced over Mike's circuit without being particularily impressed: "maybe 50% efficiency on a good day" I thought to myself. But Frank's article started me thinking that maybe the efficiency could be pretty good if the active device could be operated as a switch. I decided to do a rigorous analysis of the circuit, optimizing component values, and then check the results with a circuit analysis computer program. The results were encouraging, so I went ahead and built a prototype and WOW! - was I ever impressed!!! Not only is it considerably simpler than my push-pull design, the efficiency is higher! As a result, I no longer recommend my push-pull design! However, my analysis uncovered a few surprising characteristics (as well as some minor errors in Frank's article) so, since I still have this ego-driven desire to write something, I thought I'd share my findings with everyone:

As Frank's article pointed out, operating the device as a switch can theoretically achieve 100% efficiency. What originally frightened me about this circuit was that the switch was directly in parallel with the tank circuit. Any voltage on the capacitor when the switch is turned on would be discharged by the switch, dissipating the capacitor energy and wasting power. Since the MOSFET drain voltage oscillates about the supply voltage (rather than ground) when the switch opens, it would not normally return to zero volts after one-half cycle. To remedy this situation, the tank circuit should be DETUNED so that it oscillates for more than one-half cycle while the switch is opened. It turns out that if the tank is made resonant at 1.2915 times the operating frequency (assuming a 50% switch duty cycle) the voltage on the drain will return to very nearly zero volts when the MOSFET turns on. (Contrary to Frank's article, a 50% duty cycle is not necessary - any duty cycle may be used, the only difference being that the detuning factor will change. However, since 50% is easily produced, it is used throughout this analysis.)

It is also desirable for high efficiency that the current in the MOSFET be zero immediately following turn-on - this tends to minimize average MOSFET current for a given power output. This will occur if the inductor is completely discharged during the MOSFET "off" period, i.e., all energy stored in the inductor is transferred to the load.

For a given supply voltage, frequency, and power output, it turns out that there is an ideal inductance value and load resistance which satisfies the above condition. When these values are combined with the condition for tank resonance above, we obtain component values and and load resistance for our "optimized" circuit:

$$L = \frac{.2085 \ V^2}{P \ F} \qquad C = \frac{1}{(2 \times pi \times 1.2915 \times F)^2 \ L} \qquad Z = \frac{1.2638 \ V^2}{P}$$

where: L = tank inductance C = tank capacitance
Z = load resistance P = output (or input) power
V = supply voltage F = operating frequency

also: Vmax = peak voltage on MOSFET = 3.6311 V
Irms = rms MOSFET current = 1.1638 P / V

The above equations are the result of several hours of slaving over a table of Laplace Transforms, and numerical equation solving using a programmable calculator. Since I easily could have made an error in the calculations I decided to check my results using a circuit analysis computer program I have access to at work. I first calculated component values using the above equations, for P = 1 watt, V = 12 volts, and F = 179,000 Hz. These values worked out to:

L = 167.7 uH C = 2826 pF Z = 182 ohms

Note that the values for L and C differ markedly from those given in the "simple beacon" schematic. The value for Z is considerably greater than that given in Frank's article, as well as greater than most LowFER antennas. But since I was now in the magical world of software I could have any antenna impedance I wanted. I modeled the antenna as a 182 ohm resistor, 1000 ohm inductive reactance, and 1000 ohm capacitive reactance all in series. The active device was modeled as a switch in series with a 1 ohm resistor, opening and closing with a 50% duty cycle at a 179 kHz rate.

The analysis was run and the output voltage and switch current were plotted. Plots were made for both no load and full load. The output voltage closely approximates a half cycle sinewave at no load, but departs somewhat from sinusoidal at full load. The full load MOSFET current is seen to be zero when the switch first closes, as desired. Note also that the no load MOSFET current is initially negative and ramps positive, with the result that the average current is essentially zero, which would be expected for no load.

Encouraged by these results, I decided to build a real working output stage. I picked up an IRF 511 at Radio Shack, dug thru my junk box and found a T-150-2 powdered iron toroid core, and borrowed several mica capacitors from work which totaled about 2800 pF. I added turns to the toroid until it resonated with the caps at 231 kHz (1.2915 times 179 kHz) - this required 105 turns of #30 wire. I drove the gate of the MOSFET with a 5 volt 50% duty cycle squarewave from a function generator. For a dummy load, I used a 150 ohm resistor in series with a 3 mH inductor and 300 pF variable capacitor - the resistance of this combination was very nearly 182 ohms at resonance.

I first powered up the circuit with no load, and observed a output waveform identical with the no load output voltage plot. The supply current was about 1.2 mA. I then connected the load, and by tuning the variable cap obtained a waveform identical to the full load plot, with a supply current of 83 mA. Using the 'scope I then measured the load current, and calculated the output power and efficiency, which was an amazing 98%! The highest efficiency I ever measured with my push-pull design was 95%. The circuit was well behaved with changes in tuning, with maximum RF output and maximum current drain occuring very nearly together.

A tune-up procedure which works well is as follows: With no load, the tank is adjusted for minimum supply current (this adjustment is not too critical and the circuit will work well over a +/- 10 kHz range using fixed values). The antenna is then connected and the loading coil tuned for maximum RF. Since most LowFER antennas have a resistance of less than 182 ohms some means of impedance transformation is required. Probably the simplest way of doing this is to connect the antenna and loading coil to a tap on the tank inductor. The position of the tap should be adjusted so the transmitter draws 1 watt DC (83 ma for a 12 volt supply) when the loading coil is tuned

for max. RF output. If too much current is drawn, tap the inductor farther from the MOSFET end.

As is obvious from the output voltage plot, the circuit generates considerable harmonics. A fourier analysis was run using the circuit analysis program and the amplitudes of the first 10 harmonics were calculated (at full load):

Fundamental	0 dB	6th	-30.24 dB
2nd	-5.54 dB	7th	-33.19 dB
3rd	-16.92 dB	8th	-35.20 dB
4th	-22.66 dB	9th	-37.62 dB
5th	-27.06 dB	10th	-38.83 dB

These numbers may look scary, especially the 2nd, but shouldn't be much cause for alarm. A LowFER antenna with a Q of 100 (a rather mediocre value) will provide 37.5 dB attenuation of the second harmonic, so the radiated second harmonic will be over 43 dB below the fundamental.

For proper circuit operation, the load impedance at all harmonic frequencies should be high compared to the impedance at the fundamental. This is easily accomplished by placing a series tuned circuit in series with the load. A LowFER antenna / loading coil combination provide this automatically, but if the transmitter is going to be driving a transmission line, lowpass filter, pi-network, dummy load, or a tap on a grounded loading coil, a series tuned circuit designed for an operating Q of 5 or greater should be connected in series with the load, and tuned for maximum RF. If a low distortion sinewave is desired (e.g., for efficiency measurements), the Q can be selected based on the above harmonic levels to provide the desired harmonic distortion.

Finally, as Frank's article mentioned it is important to ensure that the MOSFET gate be driven with a fast risetime squarewave to provide switching-mode operation. Since MOSFETs have considerable input capacitance, a low impedance driving source is needed. I have had excellent results driving MOSFETs directly from HC series CMOS. The HC parts have a driving source resistance of 30 ohms or less, as compared to several k ohms for the 4000 series. I also recommend AC coupling the drive to protect the MOSFET (what if the oscillator stops and the divider output is stuck high??)

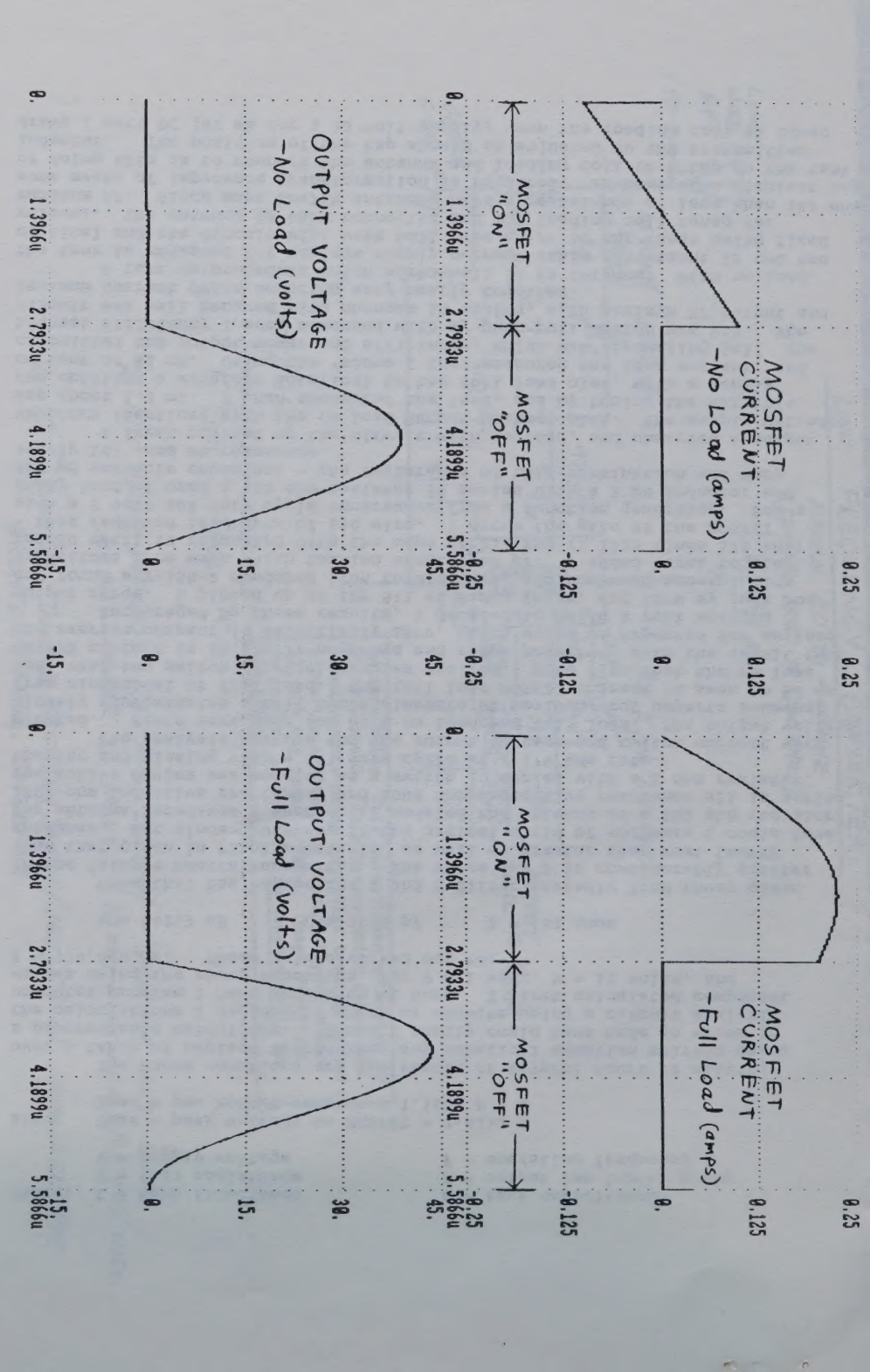
In summary, I'm just about convinced that the "simple beacon" circuit is the Ultimate Design! With the changes outlined here, it provides unmatched DC to RF efficiency, as well as being just about the simplest circuit one could hope for. What could be better?

REFERENCES:

Mike Mikeke, "Simple Beacon Construction Notes", WU #53

Jim Ericson, "Comments on the Simple Beacon", WU #57

Frank Cathell, "Analysis of the LowFER Transmitter Circuit", WU #58



A "Switching-Type" Transmitter P.A.

Max Carter

Thought I'd add my two cents worth to the great P.A. efficiency debate that seems to be raging (smouldering at least). It seems to me that when considering power amplifier efficiency we should confine ourselves to the P.A. proper, leaving aside considerations of ground resistance, coil efficiency, radiation resistance, etc. A resonant LowFER antenna system can be characterized as a pure resistance. So, in order to measure the output power of our P.A. it is only necessary to connect a carbon resistor of known value to its output, measure the voltage across this resistor and substitute the value measured in the familiar formula $P=E^2/R$. The most convenient way to make this measurement is with an oscilloscope. In making the measurement we must, however, take care to properly convert the peak-to-peak reading obtained from the 'scope to to its equivalent RMS value prior to substituting in the formula. This conversion can vary from trivial for simple waveforms to virtually imposible for complex waveforms. Fortunately, for the type of waveform to be considered here, namely a 50% duty cycle squarewave, the conversion is of the trivial variety. To convert a peak-to-peak squarewave reading to RMS we merely divide by 2. Efficiency is then found by dividing RF output power by DC input power (P=IE).

The above short tutorial is presented as a prelude to introducing the concept of the switching-type output circuit. The heck, you say! There's nothing new about this. LowFERs have been doing this for years! Ah yes , but most LowFER P.A. designers, judging from designs I've seen and statements I've read, seem wedded to Class C type circuits which are driven with waveforms of less than 50% duty cycle or, even if using true symetrical drive, seem to feel a need to convert the output to a sine wave through the use of tank circuits and/or low-pass filters before the power is applied to the antenna loading coil. This thinking, I believe, is a carry-over from QRP designs for the HF bands. I contend, and tests on my own beacon confirm, that applying a square wave directly to the feed-point of the antenna tuning circuit is just as effective, and has added advantages of simpler design and improved efficiency. The reason tank circuits and LP filters are not required is that, given the necessary high Q of the typical LowFER antenna system, the antenna system itself performs the same function!

For example, the circuit presented in figure 1 is a true switching P.A. It is probably not the simplest of LowFER P.A.'s, but is one of the most straight-forward. It is a rip-off of a circuit commonly found in high efficiency switching-type power supplies. (Need to convert your +12 V. battery power to some odd voltage at high current level? Slap some high speed Schottky rectifiers on the output of this thing, and you have a switching power converter!) Virtues include:

1) High efficiency: 90-95% easily obtained.

2) Versatility: since the output impedance of the VMOS transistors is quite low, the circuit will drive virtually any loading coil/antenna to legal power level. Power setting is accomplished by selecting the number of turns in the secondary of the output transformer. It is only necessary to experiment (or select taps) until the DC input power measures 1 Watt. (This is analogous to speaker power level setting in a public address system.)

3) Monitor-ability: a DC ammeter at your power source is all it takes to monitor all aspects of your transmitter's operation. RF feed point current is a direct function of DC input current. Loss of drive? Wet insulators? Weeds need mowing around base of tower? Snow covering loading coil? Arcing? All are indicated by abnormal current readings. Very handy when it's 20 below outside!

4) Simplicity: As you can see, the only tuned circuit in the circuit is the one formed by the antenna and loading coil. In spite of its simplicity, radiated harmonics, especially even harmonics, are spectacularly low. This, of course, is a function of the Q of your loading coil and antenna, and it is these alone which will determine how clean your signal is. If you have problems with harmonics, better to improve your coil and antenna than fool with filters and tanks!

5) Survivability: Not to say that this design is any better in this respect than others, but it has operated continously here for three summers, through every electrical storm Mother Nature could dish out, and has never blown a MOSFET. This is in contrast to reports of lightning-caused problems I hear and read about others having, especially in non West Coast areas. Perhaps this is due to the over-rated MOSFETs I used.

Construction Notes

1) Any N-channel VMOS power transistors with sufficient voltage and current capability should work in this circuit.

2) Transformer core is Amidon FT-114-75 or other high permeability torroid core.

3) Transformer windings are of 24 ga. PVC or any other wire you can fit around the core. Bifilar winding method is not recomended (too much inter-winding capacitance).

4) Excitor drive signal must be a 50% duty cycle square wave with peak-to-peak amplitude equal to or greater than 1/2 the P.A. supply voltage. Example: 6 VPP for 12 V. supply.

5) 51 ohm resistor is for terminating a long cable run from the excitor. If the excitor is in close proximity to the P.A., this resistor can be eliminated.

Tune Up

1) Connect the secondary of the transformer to the antenna loading coil feed point as shown.

2) Connect a millivoltmeter to the current monitor test points (TP 1&2). Connect a voltmeter from TP3 to ground. Adjust the loading coil inductance or optional shunt capacitor for peak current as indicated on the millivoltmeter. This adjustment will be affected to a greater or lesser degree by the proximity of the person doing the adjusting (this is a fact of life for LowFERS). Final adjustment will probably take several attemps before the optimum setting is found.

3) Calculate input power: P=IE. Note: Input current is read on the millivoltmeter as milliamperes. Example: Current = 118.4 mA, Voltage = 8.447 V.; .1184 x 8.447 = 1 Watt.

4) Adjust input power to one Watt; course setting with secondary windings (more turns = more power); fine setting with 50 ohm reostat.

5) If desired, calculate feed-point current, feed-point resistance and output power as shown in figure 2;and efficiency as shown above.

Power Supply Suggestion

For those who hate solid-state P.A.s in general and MOSFETs in particular, I offer the following: Don't forget the very low on-resistance of power FETs! If a power FET becomes biased on for any appreciable length of time without current limiting, it will go up in smoke! I suggest you limit the current output of your power source to just a bit more than what is required for operation at maximum output power. The longevity of the P.A. mentioned above may be due to the fact that, while the FET's are rated at about 12 watts dissipation each at 25 C, the supply used to power the circuit is a bit anemic; it tops out at about 2 watts. This is as it should be. Why use a power supply that can deliver 10 amps when all that is needed is a hundred mills or so. Nicad batteries in particular are noted for the prodigious current they can deliver. If you use Nicads, use a current limiting resistor, current regulator and/or fast fuse between the battery and your P.A.

Figure 1: Switching-Type P.A.

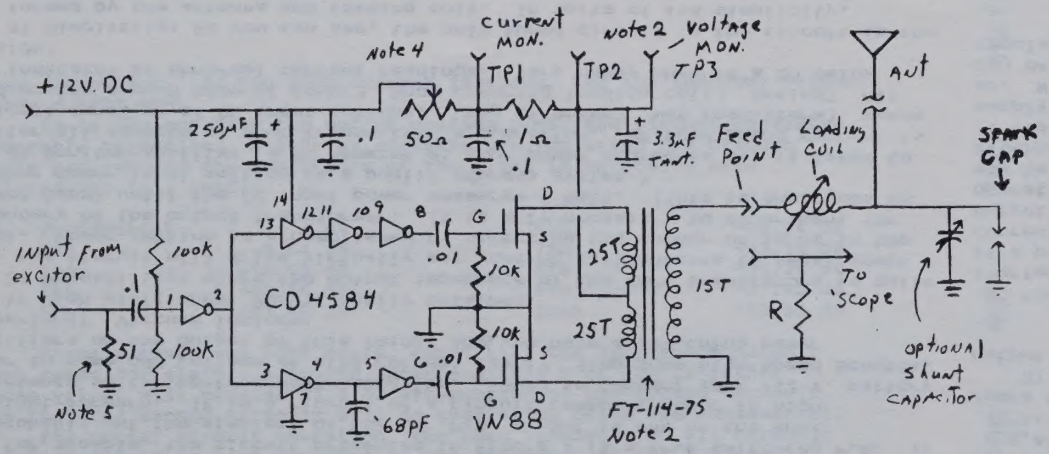


Figure 2: Calculations

Feed-point current (RMS): $I_{fp} = \left[(I_{in} - I_{core})\ (T_{pri} / 2)\right] / T_{sec}$.

Where: I_{in} = DC input current;

I_{core} = core excitation current (DC input current with load disconnected. If the core shown in figure 1 is used and wound as in figure 1, this value will be about 3 mA);

T_{sec} = number of secondary turns;

T_{pri} = number of primary turns.

Example: I_{in} = 118.4 mA, I_{core} = 3 mA, T_{sec} = 15, T_{pri} = 50;

(.1184 - .003) x (50/2) /15 = 192 mA. RMS (Since the transformer secondary, loading coil and antenna are in series, the feed-point current will very nearly equal the antenna base current.)

Feed-point resistance: Disconnect antenna loading coil and connect a variable resistor as shown. Adjust resistor until current input reading is the same value as in step 2 in the tune-up procedure (118.4 mA in example). Disconnect resistor and measure its resistance. Resistance measured will equal the feed-point resistance.

Output power: Connect a carbon resistor to output, as shown. Connect oscilloscope across resistor, as shown. Measure peak-to-peak voltage of displayed waveform (disregard ringing).

$P_{output} = (V_{pp}/2)^2 / R.$

Example: V_{pp} = 10V, R = 26 ohms. $(10/2)^2 / 26 = .96$ Watts.

Alternately: $P_{out} = I_{out}^2 R.$

Example: I_{out} = 192 mA, R = 26; $.192^2$ x 26 = .96 Watts

SYSTEM EFFICIENCY

By: J. Coote

I also think more should be tried in the area between the driver and antenna to improve efficiency. Here are some comments and experiment results that may help. Hopefully, this will stir up further experimentation and controversy. Maybe some new designs will appear.

1. FCC rules are only concerned with DC input to the PA. Drive waveform can be anything needed to get PA efficiency.

2.If a transmitter at legal input has a 50% efficiency, going to 90% efficiency is nearly double (almost+3 db) the power output. Improvements of a db can all add up.

3. Efficiency may be found by: RF watts out/DC watts in.

4. RF outputs not pure sine waves will give inaccurate power measurments. One design I tried had a poor waveform but showed an efficiency of over 110 percent!

5. RF power may be measured by: $P=E^2/2R$ (Dummyload, RF probe,VOM) or by: I^2R (Dummyload, Calibrated RF ammeter). R, whether the antenna system or dummyload has to be a known value. The VOM must be a high-Z type to avoid loading.

6. I think transmitters with PI or other toroid filter networks are easy to build and bench test. These can be designed from filter formulas and tables in amateur and other radio books. During adjustment, the filters terminate in a dummyload (usually 50 ohm). The RF probe ($E^2/2R$) is attached across the load. The inductors are tapped, or capacitors changed for best efficiency- not highest power output.

7. You may get higher efficiency with "larger" components. T-200-3 cores replaced small T-106-3 cores. 630 volt poly or high-voltage disc caps were used. A 1mF DC blocking cap was used instead of .022mF. Larger cores allow thicker wire and make tapping easier.

8. A few LowFER transmitters used .047 caps in a PI filter. I tried .047, .033, .022 and .02 caps. Efficiency increased with smaller-value caps and extra turns. The lowest efficiency was with a T-106 core and .047's- about 62%. With a T-200 core and .047's it rose to 70%. With .033's efficiency was near 76%. .022's produced about 81%. .020 discs gave about 82% efficiency. .015 caps produced an uneven waveform impossible to measure. It is important to experiment with coil and cap values.

9. Later I read up on filters and found that in a symmetrical PI the X of each of the three components must equal 50 ohms.
In checking the reactance chart I found that .022 or .020 mF. is closer to a 50-ohm X at 185 kHz.

10. I also started work on a halfwave filter. Using this filter with the same drain voltage/same device produced higher input and output powers than the PI designs.
Tests with this filter are incomplete. Adjusting between the two toroids and three caps is time consuming. My best efficiency so far has been 68-70%.
In this filter the two toroids and two outer caps have an X of 50 ohms. The inner cap has an X of 25 ohms. This might be a promising filter. One experiment might be to try skewing the toroid or cap values a little in order to get better match or efficiency between powerFET and load.

11. I wasted time trying to get matching values for a PI network using old-fashioned tube formulas. The scaled-down values were ridiculous and probably very lossy. I'd stick with symmetrical filter designs as a basis for tweaking coils and caps.

12. I tried tapping the drain RF choke as an autotransformer. I hoped to get a better match between the unknown Z of the powerFET and 50 ohms of the PI filter. At one tap setting efficiency did improve- about 74%. In view of the better efficiency with the other PI networks this was a time wasting exercise. The idea might be useful in other applications though.

13. In my tests I used IRF 511's and IRF 521's. 13 volts was used in most tests of efficiency.
At these ratings the transmitters delivered 2-5 watts into the 50-ohm dummyload.

14. I tried a variable DC supply on the transmitters in order to get DC input to a FCC-legal level. Unfortunately, efficiency dropped 15 to 20%. Remedies might be readjusting filter L and C values or trying different FETs. Ideas?

15. I heard that powerFETs work "better" (more efficiently?) at higher voltages above the 12-18 volt area. To stay legal, my transmitters had to be cranked down to 5 or 6 volts.

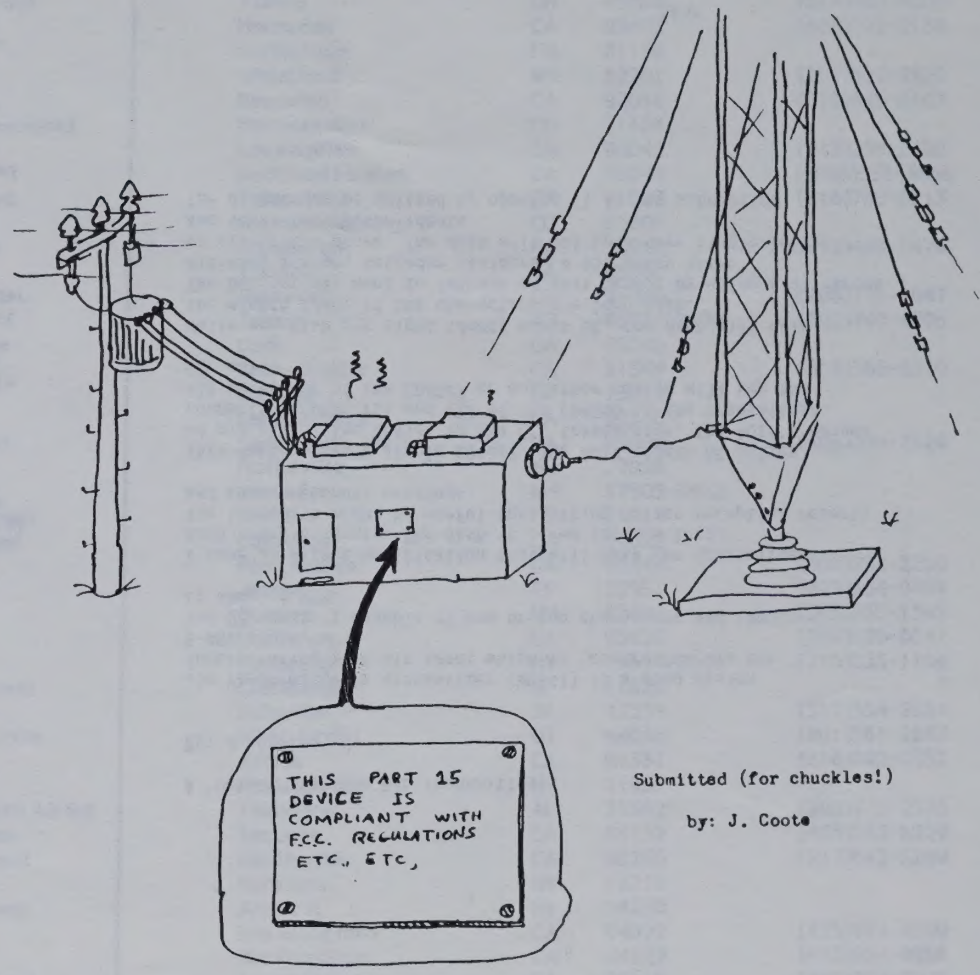
16. My tests all used the Mike Mideke CD4060 oscillator/divider/driver. In a few later tests I added the two-transistor buffer in WU#58 and got around 2 to 3% efficiency increase

17. While keeping the oscillator regulated it might be worthwhile to try separate adjustable power supplies on the buffer and transmitter. This might help efficiency. In contrast, some old LowFER material showed a transmitter that used a handful of chips- just for the oscillator. In addition an L/C filter was placed between the driver and gate of the powerFET- to round off the squarewave! How's his efficiency?

18. Filter type transmitters may be easy to build but matching to the antenna may seem complicated. Assuming the loading coil is tuned, Z may be from 10 to 200 ohms and probably not a nice 50 ohms.
Though I haven't tried this yet, a broadband matching transformer between transmitter and loading coil should insure the most power to the antenna. Those of who are hams wouldn't run our 50 ohm transmitters into an unknown load without a matching device.
The transformer could be wound "conventional" or "balun" style on a large core such as an Amidon FT-240-77. If the primary is assumed to be 50 ohms, primary XL should be 4Z or 200 ohms. The secondary should probably be double the primary turns to start. The secondary could be tapped and the taps calibrated using different dummyload resistors and RF power measurment technique. Transformer loss can be tested by running the transmitter alone into 50 ohms, then comparing power through the transformer into a 50-ohm or other load.
Transformers and matching devices whether part of or added to the transmitter can help our efficiency a lot and need more experimentation.

19. Another area of experimentation is in loading coils. Comparisons of coil efficiency are needed- Large vs. small, Litz vs. solid, ferrite vs. airwound and variometers vs. parallel cap across part of the coil.
Test methods might be actual on-air observations and calibrated RF ammeters.

20. Lots of fine work on antennas has been done- especially in some WU and Lowdown articles of a few years ago. In these tests antennas were compared (and grounds) one right after the other- over the same path to the same receiver.
Future experiments might be in large loops for transmitting or the pros and cons of running a 50-foot vertical wire a few feet away from a much taller metal tower without connection to the tower.



Submitted (for chuckles!)

by: J. Coote

Additional Comments on the LowFER Transmitter Circuit

By Frank Cathell (H, H2)

After writing the article on the "typical" LowFER transmitter circuit in WU #58 I felt obligated to fully test my H2 transmitter to see how well it conforms to theory. The H2 antenna shows approximately 72 ohms of ground resistance when resonated. This was checked using a resistance bridge and the resistor substitution method described on page 35 of Mike Mideke's "Transmitting Antennas and Ground Systems for 1750 Meters". The result of either measurement method was within 5% of the other. With one watt input, the drain of the power mosfet has an impedance of about 72 ohms so the pa to antenna match is nearly perfect at this power level.

An initial efficiency measurement of input to output power (antenna current was measured with a high frequency current probe) showed about 62%, which is poor for a Class F radio frequency amplifier. So, I proceeded to investigate the circuit operation and found the following:

1. The resonant frequency of the drain tank circuit (L1/C6) must be tuned slightly higher than the transmitting frequency in order to produce a distortion free 1/2 sine wave voltage envelope on the mosfet's drain at turn-off. The gate drive signal was a resonably good 50% duty cycle square wave.

2. Some power dissipation was evident in the L1 coil itself. This was apparently due to ac losses (skin effect) that resulted in using a single strand of #22 wire to wind the coil. The single stranded wire was replaced with litz wire composed of many strands of #36 wire and the new tank coil showed no evidence of heating under prolonged "key-down" conditions.

The antenna current was again measured after readjusting the dc input to 1 watt and showed an incredible 30% increase! The efficiency now measured just over 90% with 0.9 watts of power going to the antenna.

The same modifications were made to the "H" transmitter and its efficiency also improved to better than 90%. So it does appear that the efficiency of the typical LowFER transmitter can be made high if careful consideration is given to specific circuit parameters that contribute to power dissipation, especially the construction and tuning of the broadband tank circuit. I wonder where the other 8% or so is going???

A "Dasher" for the QZL Transmitter

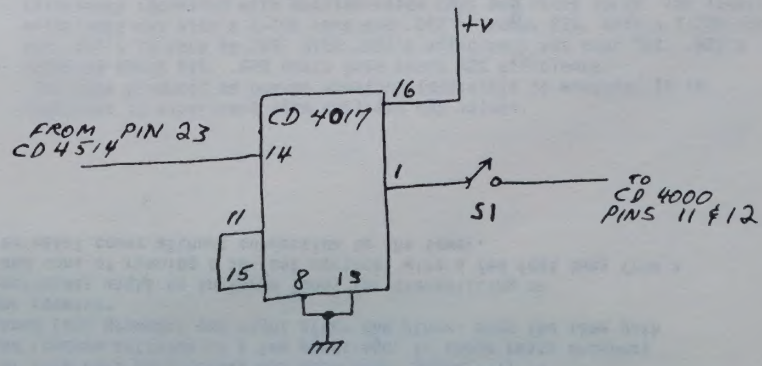
By: J. Coote

Jim Vandermaaten's transmitter (WU#41) is a good design incorporating a 16-bit ident which is controlled via the 6-mHz clock.
The QZL unit is capable of one or two characters and idents at about 4 WPM.

I came up with a modification that will make the transmitter dash every 8 idents. The dash is a few seconds long.
The long dash might be useful for getting better reception reports and chart recorder readings.

This dasher uses a single CD4017. The 4017 counts DC pulses on pin #23 of the CD4514 in the QZL transmitter. The 4017's output connects to pins #11 and #12 of the CD4000 in the transmitter.
+12 volts out of the CD4017 or any other source will key the QZL unit.

While one dash per eight idents works OK, the dash will walk on the eighth ident if the characters are long ones.
The builder may want to improve on this dasher by using a different dividing scheme, cascaded dividers, a 555 delay timer or all of the above. The dash will not walk over single letter and short two letter idents.
The dasher may be omitted by opening S1 in the schematic.



WESTERN UPDATE ACTIVE LIST as of September 24, 1988

Anderson	Brice	BA	W9PNE	PO Box 14	Lancaster	IL	62855	(618)299-2441
Armstrong	Lloyd			3813 Lancaster Drive	Pueblo	CO	81005-3065	
Babcock	David		WA6EBH	2940 Cheyenne Road	Riverside	CA	92506	
Bahr	Leland	LEE	W0YT	914 Golden Bear Lane	Kingwood	TX	77339-2914	(713)359-5284
Baker	Brad			21024 Bear Creek Road	Los Gatos	CA	95030	
Balfour	Herb	OHH	VE3OHH	91 Elgin Mills Road West	Richmond Hill (Canada)	ONT	L4C4M1	(416)884-5355
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Bittner	Mike			27215 Sunnyridge Road	Palos Verdes	CA	90274	
Bond	Robert		WD6BCN	1420 McLoughlin Avenue	Oxnard	CA	93035	(805)985-0159
Borglum	James			5549 Lesa Road	La Mesa	CA	92041	(619)464-3250
Bowers	William			11542 South Kirkwood	Stafford	TX	77477	(713)530-4364
Bradley	Dave		W6CUB	PO Box 23922	San Jose	CA	95153	
Brady	Aaron	QH		41458 N. 50th St. West	Quartz Hill	CA	93536	(805)943-1580
Bumpus	Carle			930 Idylberry Road	San Rafael	CA	94903	
Burhans	Ralph			161 Grosvenor Street	Athens	OH	45701	(614)593-8207
Buttschardt	Cliff	HDOMBAY, C	W6HDO	950 Pacific Street	Morro Bay	CA	93442	(805)772-2132
Canby	George			PO Box 80634	Springfield	MA	01138	
Carter	Max	MAX		46 - 14th Street	Wheatland	WY	82201	(307)322-9439
Cathell	Frank	H	K3YAZ	PO Box 535	Descanso	CA	92016	(619)445-8167
Chastant	Lloyd		W3NF	11680 Old Frederick Road	Marriotsville	MD	21104	
Coote	James	J	WB6AAM	808 North Ave. 66	Los Angeles	CA	90042	(213)258-7490
Costa	Bob		KB6QXM	P.O. Box 600	Redwood Estates	CA	95044	((408)353-3656
Curry	David	PLI	WD4PLI	4415 Cahuenga Blvd.	Toluca Lake	CA	91602	(818)760-0213
Cutter	Robert	CO	KI0G	701 19th Street	Glenwood Springs	CO	81601	
DeVaughn	Bob	NBD	K3NBD	829 Estella Street	Pittsburgh	PA	15210	(412)488-1479
Eatough	Charles		W6UTN	610 Palacia Court	Turlock	CA	95380	
Ericson	Jim	EK	KG6EK	226 Charles Street	Sunnyvale	CA	94086	(408)773-8947
Farkas	Greg	AZ	AK7Y	PO Box 17074	Tucson	AZ	85731-7074	(602)749-4796
Farnsworth	Charles			506 Rutledge Drive	Lodi	CA	95240	
Faulkner	Charles	FPV	W6FPV	15844 McKeever	Granada Hills	CA	91344	(818)366-6210
Fisher	Montie		WA5TSL	808 Brett Drive	Edmond	OK	73013	
Fitzgerald	Walt		W6KNG	15007 Notil Way	Lake Elsinore	CA	92330	
Forsman	Stan			1312 Burrows Road	Campbell	CA	95008	(408)374-2129
Hedspeth	Scott		WB4YZA	Route 4, Box 146	Mocksville	NC	27028	
Hill	Alan		N5BGC	2020 Calle Perdiz	Sante Fe	NM	87505-5432	
Holland	David	DCH	K3YAY	300 South Main Street	Berlin	MD	21811	
Hooper	William		KF6AR	366 S. El Monte Road	Los Altos	CA	94022	
Horton	Bob	MSG	W6MSG	2 Fresno Street	Paso Robles	CA	93446	(805)238-2250
Humphrey	Lee		WD5BTU	Rt. 2, Box 449	Jasper	TX	75951	(409)384-9489
Isbell	Daryl		KB5EDW	Box 2146 C.S.	Socorro	NM	87801	(505)835-1395
Johnson	Dave	F		713 Texas Ave.	Los Banos	CA	93635	(209)826-0841
Johnson	David		WB7ACG	PO Box 15646	Rochester	NY	14615-0646	(716)235-1104
Johnson	Don			602 East Green Street	Champaign	IL	61820	
Johnston	David	9HDQ	K9HDQ	RR1, Box 108C	Daleville	IN	47334	(317)354-2884
Jones	Ron		K7RJ	9241 S. Toni Lee Circle	West Jordan	UT	84088	(801)561-2685
Jones	Wallie		W6SZQ	9090 Nagle Ave.	Arleta	CA	91331	(818)892-0552
Kassel	Charles			114 Church Drive	Mastic Beach	NY	11951	
Keeley	Roy			Route 3, Box 316 Salt Air Rd.	Theodore	AL	36582	(205)973-2516
Keller	Eb			2984 Fallwood Lane	San Jose	CA	95132	(408)263-6229
Kincaid	Nilan		W6EIG	5529 W. 140th Street	Hawthorne	CA	90250	(213)643-5269
Knight	David			4240 Fay Road	Syracuse	NY	13219	
Kraus	Howard	K2UD		372 Callodine Avenue	Amherst	NY	14226	
Larsen	Ed	NX	KF6NX	26370 Ginny Lane	Los Altos Hills	CA	94022	(415)941-4699
Layer	Hal		N6SPD	PO Box 27676	San Francisco	CA	94127	(415)661-6958
Lee	Mitchell	MEL	KB6FPW	172 North 24th Street	San Jose	CA	95116	(408)298-3026
Leonardelli	John			Box 722, Station A	Downsview (Canada)	ONT	M3M3A9	(416)745-0491
Lundgren	Carl	TH	W2AZQ	60 Woodhollow Road	Colts Neck	NJ	07722	(201)842-4780

Mallory	Mark	MPM	WB7CAK	5196 Cobblecreek Road #7K	Salt Lake City	UT	84117	
Manley	Dean		KH6B	2058 Ainaola Drive	Hilo	HI	96720-3638	(808)959-8257
Marineau	Patrick		K9HF	3443 Illinois Avenue	St. Louis	MO	63118	
Marshall	Dave			440 Larry Drive	Florissant	MO	63033	
Martin	Steve		NK3R	141 Bridgecreek Drive	Goose Creek	SC	29445	(803)797-3143
Maxwell	James		W6CF	PO Box 473	Redwood Estates	CA	95044	(408)353-2094
McGreevy	Steve	TLX	N6NKS	45 Elda Drive	San Rafael	CA	94903	(415)479-4259
Mideke	Mike	SKY	WB6EER	Box 123	San Simeon	CA	93452	
Morgan	Robert		KA0FTA	2817 West St. Anne	Rapid City	SD	57702	
Olson	Keith	7FS	W7FS	E. 15470 Highway 106	Belfair	WA	98528	(206)275-2560
Owens	James	Q	NW00	1363 Tipperary	Boulder	CO	80303	
Paschal	Ev			61 Yale Road	Menlo Park	CA	94025	
Pepe	Bill		WA2TDR	Box 1915	Bloomfield	NJ	07003	
Peterson	Art			851 31st Street	Richmond	CA	94804	(415)234-2014
Phillips	Ed	IZJ	W6IZJ	408 North Alabama Street	San Gabriel	CA	91775	(818)285-8308
Pomplun	Don		K2BIO	521 Van Buren Place	San Ramon	CA	94583	(415)829-7648
Post	Kendall			1842 Hoffman Street	Madison	WI	53704	(608)244-0500
Raney	David	UPN	WC8E	4128 Linden Avenue	Cincinnati	OH	45236	(513)791-0740
Rappold	Sam	ZYK	WB6ZYK	PO 1267/379 Briceland Road	Redway	CA	95560	
Ratzlaff	Steve	SR	AA7U	900 Henderson / 60A	Sunnyvale	CA	94086-9059	(408)248-0343
Raven	Gregory	TEXAS	KF5N	4550 Sunnybank Court	Fort Worth	TX	76137	(817)485-6771
Reid	Frank		W9MKV	Box 5283	Bloomington	IN	47407-5283	
Remington	Sheldon	HO	NI6E	PO Box 2094	Pahoa	HI	96778	
Roberts	Todd	ABC	WD4NGG	PO Box 1413	Hilton Head Island	SC	29925	(803)681-8114
Satterthwaite	Ed			4189 Willmar Drive	Palo Alto	CA	94306	
Schick	D.H.			580 N. Buena Vista Dr.	Lake Alfred	FL	33850	
Schumacher	Jon	NVA	K7NV	Star Rt., Box 55255	Pahrump	NV	89041	
Seamons	John	JKS	KF6VO	95 Holstein Road	San Anselmo	CA	94960	(415)456-6090
Seden	Randy	ELU	WD6ELU	1272 Harold Avenue	Simi Valley	CA	93065	(805)583-5687
Sethman	Bob			92 Allen Plan	Donora	PA	15033	
Skillin	Boyd		K6MGX	3876 East Pico	Fresno	CA	93726	(209)222-0275
Smith	Randy			19515 Frederick Rd. #135	Germantown	MD	20874	
Snow	John		N6AMZ	3708 Judah Street	San Francisco	CA	94122-1227	
Spencer	Chris	FAW	WB7FAW	722 West 1850th North	Orem	UT	84057	(801)225-7852
Statom	Mike			1604 S. Campbell Avenue	Alhambra	CA	91803	(818)289-7170
Stewart	Don			2617 Anza Street	Bakersfield	CA	93305	(805)871-7024
Stinson	Dave	NTS	AB5S/7	1400 E. Reno #72	Las Vegas	NV	89119	(702)736-6021
Sullivan	John			2069 Touraine Lane	Half Moon Bay	CA	94019	
Taylor	Al			112 Cook Road	Whitehorn	CA	95489	(707)986-7775
Thompson	Arliss	AT	W7XU	7314 SW 28th	Portland	OR	97219	(503)293-1258
Tracy	John		WB7AMC	10431 Miller Avenue	Cupertino	CA	95014	(408)257-9585
Turner	Clint	CT	KA7OEI	132 West 2800 South	Bountiful	UT	84010-6447	(801)298-3393
Vanderbeek	Herb	G, V, 8-dits	WY6G	630 Ashton Avenue	Palo Alto	CA	94306	(415)493-1726
Vandermaaten	Jim	SM	WB6QZL	1276 Tourney Drive	San Jose	CA	95131	(408)258-6872
Waldsmith	Gary	SUK	K4SUK	3550 Ridgeview Drive	Eldorado Hills	CA	95630	(916)933-3815
Weiss	Jim		W9ZMV	c/o Radio WTAQ	LaGrange	IL	60525	(312)579-9104
Welch	James		KK6N	3071 Mauricia Avenue	Santa Clara	CA	95051	
Whipple	Dan			11726 Norway Street	Coon Rapids	MN	55433	
Wright	Rick	1SUN	KA5YWH	Box 4181, Station A, SEOSU	Durant	OK	74701	
Wyatt	Frank		N6FW	855 Ticonderoga Drive	Sunnyvale	CA	94087	(408)737-8155
Zizelman	John		KA5RPU	1301 S. Alexander Drive	Baytown	TX	77520	